МИНОБРНАУКИ РОССИИ

Федеральное государственное бюджетное
образовательное учреждение высшего образования
«Юго-Западный государственный университет»
(ЮЗГУ)

Кафедра иностранных языков

УТВЕРЖДАЮ
Проректор по учебной работе
_________ О.Г. Локтионова
«___» _________ 2016 г.

НАНОТЕХНОЛОГИЯ И МИКРОСИСТЕМНАЯ ТЕХНИКА

Методические указания по английскому языку
для практических занятий и самостоятельной
работы студентов направления подготовки
28.03.01.

Курск 2016

УДК 811.111 (075)

Составитель Е.Н. Землянская

Рецензент
Кандидат социологических наук, доцент Л.В. Левина

Нанотехнология и микросистемная техника: методические указания по английскому языку для практических занятий и самостоятельной работы студентов направления подготовки 28.03.01 / Юго-Зап. гос. ун-т; сост. Е.Н. Землянская. - Курск, 2016. - 49 с. Библиогр.: с.49.

Способствует формированию навыков перевода, а также усвоению необходимого минимума словарного состава текстов по направлению подготовки, включая общенаучную и терминологическую лексику.

Предназначены для практических занятий и самостоятельной работы студентов направления подготовки 28.03.01. Нанотехнология и микросистемная техника.

Текст печатается в авторской редакции

Подписано в печать 29.06.16. Формат 60х84 1/16.

Усл.печ. л. 2,6. Уч.-изд.л. 2,3.Тираж 100 экз. Заказ 648. Бесплатно.
Юго-Западный государственный университет
305040, г. Курск, ул. 50 лет Октября, 94.

Unit I

Nanotechnology

1. Try to guess the meaning of the following international words. Look at these words again. Are they nouns (n), verbs (v) or adjectives (adj):

Nanotechnology, control, atomic, molecular, structure, nanometer, material, nanomaterial, synthesis, physical, chemical, optical, ingredient, experiment, debate, economics, engineer, medicine, magnitude, electronics, energy, technology, equivalent.

2. Practice the following words:

Atom ['ætəm], synthesis ['sinθisis], nanometers [nænəu'mi:tə], chemical ['kemikəl], catalyst ['kætəlist], nanostructure [nænəu'strΛktʃə], toxicity [ta:k'sisəti].

3. Read and memorize the following words:

nanotechnology – нанотехнология
dimension – измерение
nanometer – миллимикрон
interaction – взаимодействие
catalyst – катализатор
molecule – молекула
atom – атом
layer - слой
solid – твердое тело
scale – уровень
to deal with – иметь дело с
diverse – разнообразный
extension – расширение
range –спектр
toxicity – токсичность
speculation – предположение

to warrant – гарантировать
effect - действие

4. Read and translate the text.

Nanotechnology

Nanotechnology, shortened to “nanotech”, is the study of the controlling of matter on an atomic and molecular scale. Nanotechnology deals with structures of the size 100 nanometers or smaller in at least one dimension, and involves developing materials or devices within that size. Nanostructures are assembled a single atom, molecule, or atomic layer at a time, as part of a vast new field of research in nanomaterials synthesis and assembly.

Generally, structures smaller than a nanometer tend to behave much like individual atoms, while materials that are hundreds of nanometers or greater in size exhibit properties of the continuum. Nanoscale properties and behaviors can be quite different as the result of unique physical and chemical interactions. The preponderance of surfaces and interfaces, and the physical confinement of matter and energy, can alter nearly all properties of materials (physical, chemical, optical, etc.), and thus produce extraordinary new behaviors. Examples include generating light from dark materials, improving efficiencies of catalysts by orders of magnitude, and turning soft and ductile materials like gold into solids with hardness equivalent to bearing steel.

The final ingredient to nanotechnology is the ability to characterize and predict nanoscale properties and behavior. New experimental tools that are able to “see”, “touch”, and measure the behavior of individual nanostructures allow scientists and engineers to identify subtle differences in structure and properties that control nanoscale properties. By coupling new experimental techniques with advanced computational tools, researchers can develop, verify, and refine models and simulations that will allow the full potential for nanotechnology to be explored.

There has been much debate on the future implications of nanotechnology. Nanotechnology has the potential to create many new materials and devices with a vast range of applications, such as in medicine, electronics and energy production. On the other hand, nanotechnology raises many of the same issues as with any introduction of new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):

1. На атомном и молекулярном уровне	a) to improve efficiencies of catalysts
2. иметь дело со структурами размером в 100 миллимикронов	b) as the result of physical and chemical interaction
3. как результат химического и физического взаимодействия	c) on an atomic and molecular scale
4. изменять химические и физические свойства материалов	d) to deal with structures of the size 100 nanometers
5. улучшать эффективность катализаторов	e) to alter physical and chemical properties of materials
6. вырабатывать свет	f) to characterize and predict properties of nanostructures
7. превращать пластичные материалы в твердые	g) to generate light
8. исследовать весь потенциал нанотехнологии	h)to turn ductile materials into solids
9. характеризовать и предсказывать свойства наноструктур	i) effects of nanomaterials on global economics
10. действие наноматериалов на глобальную экономику	j) to explore the full potential of nanotechnology
11. широкий спектр применения наноматериалов	k) concerns about the toxicity of nanomaterials
12. беспокойства по поводу	l)a vast range of applications

токсичности наноматериалов of nanomater

6. Use the noun suffixes to convert verbs into nouns:

To regulate	**- Tion, sion**	Regulation
To exhibit		
to develop		
to interact		
to predict		
to create		
to produce		
to introduce		
to speculate		
to govern	**-ment**	government
to develop		
to confine		
to measure		

7. Look through the text again and discuss with your group mates whether the following statements are true or false:

1) Nanotechnology is creating an entirely new class of materials and devices with unique and potentially very useful properties.

2) The physical dimensions of nanotechnology are small, spanning from just a few to tens of nanometers.

3) Nanotechnology is very diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to investigating whether we can directly control matter on the atomic scale.

4) Nowadays current interest in nanotechnology is not high.

5) The field of nanotechnology is developing slowly as are its practical application.

6) Unique nanoscale properties are already being used to increase energy efficiency and improve healthcare.

8.Answer the questions to the text:

1) What is nanotechnology?

2) What does nanotechnology deal with?
3) Which properties do materials hundreds of nanometers in size exhibit?
4) What is the final ingredient to nanotechnology?
5) What is the application of nanotechnology?

Unit II

The history of nanotechnology

1. Try to guess the meaning of the following international words. Are they nouns (n), verbs (v) or adjectives (adj):

Era, phenomena, gravity, start, microscope, carbon, quantum, nanocrystal, metal, oxide, magnitude, concept.

2. Practice the following words:

Microscope ['maikrəskəup], oxide ['a:ksaid], gravity ['græviti], quantum ['kwa:ntəm], carbon ['ka:bən].

3. Read and memorize the following words:

individual atoms – одиночные атомы
semiconductor – полупроводник
fullerenes – фуллерены
nanoparticles – наночастицы
oxide – окись
van der Vaals attraction – Ван-дер Ваальсовы силы
gravity – сила тяжести
carbon nanotubes – углеродные нанотрубки
magnitude – величина
nanocrystals - нанокристаллы

4. Read and translate the text:

The history of nanotechnology

The first use of the concepts found in 'nano-technology' (but predating use of that name) was in "There's Plenty of Room at the Bottom," a talk given by physicist Richard Feynman at an American Physical Society meeting at Caltech on December 29, 1959. Feynman described a process by which the ability to manipulate individual atoms and molecules might be developed, using one set of precise tools to build and operate another proportionally smaller set, and so on down to the needed scale. In the course of this, he noted, scaling issues would arise from the changing magnitude of various physical phenomena: gravity would become less important, surface tension and van der Waals attraction would become increasingly more significant, etc. This basic idea appeared plausible, and exponential assembly enhances it with parallelism to produce a useful quantity of end products. The term "nanotechnology" was defined by Tokyo Science University Professor Norio Taniguchi in a 1974 paper as follows: "'Nano-technology' mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or by one molecule." In the 1980s the basic idea of this definition was explored in much more depth by Dr. K. Eric Drexler, who promoted the technological significance of nano-scale phenomena and devices through speeches and the books Engines of Creation: The Coming Era of Nanotechnology (1986) and Nanosystems: Molecular Machinery, Manufacturing, and Computation, and so the term acquired its current sense. Engines of Creation: The Coming Era of Nanotechnology is considered the first book on the topic of nanotechnology. Nanotechnology and nanoscience got started in the early 1980s with two major developments; the birth of cluster science and the invention of the scanning tunneling microscope (STM). This development led to the discovery of fullerenes in 1985 and carbon nanotubes a few years later. In another development, the synthesis and properties of semiconductor nanocrystals was studied; this led to a fast increasing number of metal and metal oxide nanoparticles and quantum dots. The atomic force microscope (AFM or SFM) was invented six years after the STM was invented. In 2000, the United States National Nanotechnology Initiative was founded to coordinate Federal nanotechnology research and development and is evaluated by the President's Council of Advisors on Science and Technology.

5. Search the text for the English equivalents of the following Russian phrases:

Определять термин «нанотехнология»; процесс деформации и разделения материалов атомом или молекулой; привести к открытию фуллеренов; увеличение количества металлов; управлять одиночными атомами; координировать нанотехнологические исследования; отмечать технологическую значимость наноприборов, технологическая значимость явлений в наноразмерной среде, сканирующий туннельный микроскоп (СТМ), квантовые точки, атомно-силовой микроскоп (АСМ).

6. Discuss with your group mates whether the following statements are true or false:

1) The term 'nanotechnology' was first defined by physicist Richard Feynman in the USA.
2) The term 'nanotechnology' acquired its current sense in the 1980s.
3) The birth of cluster science and the invention of the scanning tunneling microscope prompted the start of nanoscience.
4) The study of the synthesis and properties of semiconductor nanocrystal led to the discovery of fullerenes and carbon nanotubes.
5) The canning tunneling microscope was invented six years earlier than the atomic force microscope.

7. Convert nouns into adjectives:

Technology	**- al**	technological
experiment		
environment		
nation		
energy	**-tic**	Energetic

8. Answer the questions to the text:

1) What did Richard Feynman describe at an American Physical Society on December 29, 1959?
2) How was the term 'nonotechnology' defined by Professor Norio Taniguchi in 1974?

3) When did the term ‘nonotechnology’ acquire its current sense?

4) Which book is considered to be the first on the topic of nanotechnology?

Unit III

Fundamental concepts of nanotechnology

1. Try to guess the meaning of the following international words. Are they nouns (n), verbs (v) or adjectives (adj):

Mycoplasma, carbon, diameter, bacteria, nanoelectronics, nanomechanics, nanophotonics.

2. Practice the following words:

Cellular ['seljələ], bacteria [bæk'tiəriə], scenario [si'na:riəu], diameter [dai'æmitə].

3. Read and memorize the following words:

DNA – ДНК
cellular – клеточный
double-helix – двойная винтовая спираль
Mycoplasma – микоплазма
top-down – сверху вниз
bottom-up – снизу вверх
genus – род
bacteria – бактерия
outcome – результат
approach – подход
entities – объекты
to evolve – развивать
carbon-carbon bond – углерод-углеродная связь

4. Read and translate the text.

Fundamental concepts of nanotechnology

One nanometer (nm) is one billionth, or 10^{-9}, of a meter. By comparison, typical carbon-carbon bond lengths, or the spacing between these atoms in a molecule, are in the range 0.12–0.15 nm, and a DNA double-helix has a diameter around 2 nm. On the other hand, the smallest cellular life-forms, the bacteria of the genus Mycoplasma, are around 200 nm in length. To put that scale in another context, the comparative size of a nanometer to a meter is the same as that of a marble to the size of the earth. Or another way of putting it: a nanometer is the amount a man's beard grows in the time it takes him to raise the razor to his face. This analogy is clearly subjective to specific scenario and also situational differences that may change the outcome of the event. So the speed at which is stated is just an example of an "average" that can measure the speed. Two main approaches are used in nanotechnology. In the "bottom-up" approach, materials and devices are built from molecularcomponents which assemble themselves chemically by principles of molecular recognition. In the "top-down" approach, nano-objects are constructed from larger entities without atomic-level control. Areas of physics such as nanoelectronics, nanomechanics and nanophotonics have evolved during the last few decades to provide a basic scientific foundation of nanotechnology.

5. Insert the prepositions into the following sentences:

1) One nanometer is one billionth … a meter.
2) A DNA double-helix has a diameter … 2 nm.
3) The bacteria … the genus Mycoplasma is … 200 nm … length.
4) There are two main approaches used … nanotechnology.
5) Materials and devices are built … molecular components which assemble themselves chemically … principles … molecular recognition … the "bottom-up" approach.
6)… the "top-down" approach, nano-objects are constructed … larger entities … atomic-level control.

6.Translate the following into Russian:

One billionth of a meter; a DNA double-helix; the smallest cellular life-forms; the bacteria of the genus Mycoplasma; to build materials and devices from molecular components; to assemble themselves chemically by principles of molecular recognition; to be constructed from larger entities without atomic-level control.

7.Answer the following questions:

1) What is the size of nanometer to a meter?
2) Which diameter has a DNA double helix?
3) What is the length of the bacteria of the genus Mycoplasma?
4) Which approaches are used in nanotechnology?
5) What is the difference between the approaches?

Unit IV

Nanomaterials

1. Try to guess the meaning of the following international words. Are they nouns (n), verbs (v) or adjectives (adj):

Diffusion, ion, nanoionics, nanomechanics, biomaterial, aluminum.

1. Practice the following words:

Ratio ['reiʃiəu], ion ['aiən], opaque [əu'peikou], combustible [kəm'bΛstibl], catalyst ['kætlist], inert [i'nɜ:t].

2. Study the vocabulary list:

Reduction - сокращение
quantum effects – квантовые эффекты
ratio – отношение
catalytic – каталитический
ion – ион
opaque – непрозрачный
transparent – прозрачный
insoluble – нерастворимый
inert – инертный
catalyst – катализатор
combustible material – горючее вещество

3. Read and translate the text.

Larger to smaller: a materials perspective

A number of physical phenomena become pronounced as the size of the system decreases. These include statistical mechanical effects, as well as quantum mechanical effects, for example the "quantum size effect" where the electronic properties of solids are altered with great reductions in particle size. This effect does not come into play by going from macro to micro dimensions. However, quantum effects become dominant when the nanometer size range is reached, typically at distances of 100 nanometers or less, the so called quantum realm. Additionally, a number of physical (mechanical, electrical, optical, etc.) properties change when compared to macroscopic systems. One example is the increase in surface area to volume ratio altering mechanical, thermal and catalytic properties of materials. Diffusion and reactions at nanoscale, nanostructures materials and nanodevices with fast ion transport are generally referred to nanoionics. *Mechanical* properties of nanosystems are of interest in the nanomechanics research. The catalytic activity of nanomaterials also opens potential risks in their interaction with biomaterial. Materials reduced to the nanoscale can show different properties compared to what they exhibit on a macroscale, enabling unique applications. For instance, opaque substances become transparent (copper); stable materials turn combustible (aluminum); insoluble materials become soluble (gold). A material such as gold, which is chemically inert at normal scales, can serve as a potent chemical catalyst at nanoscales. Much of the fascination with nanotechnology stems from these quantum and surface phenomena that matter exhibits at the nanoscale.

5. Find in the text English word-combinations corresponding to the following Russian ones:

Сокращение размера частиц**;** изменять электронные свойства твердых частиц; изменять физические свойства материалов; исследования в наномеханике; механические свойства наносистем; взаимодействие наноматериалов с биоматериалами; уменьшать материалы до наноуровня; превращать непрозрачные вещества в прозрачные; быть инертным; служить мощным химическим катализатором на наноуровне, нерастворимый материал, растворимое вещество, активность катализатора, наноструктурные материалы, квантово-механический эффект, каталитические свойства.

6.Complete the following sentences:

1) Quantum effects become dominant when the nanometer size range is reached, typically at distances of … .
2) Diffusion and reactions at nanoscale, nanostructures materials and nanodevices with fast ion transport are generally referred to … .
3) *Mechanical* properties of nanosystems are of interest in … .
4) Opaque substances reduced to the nanoscale become … .
5) Stable materials reduced to the nanoscale turn … .
6) Insoluble materials reduced to the nanoscale become … .
7) Gold, which is chemically inert at normal scales, can serve as … .

7.Answer the following questions:

1) When do quantum effects become dominant?
2) What does nanomechanics study?
3) Do materials reduced to the nanoscale exhibit the same properties as on a macroscale?
4) When can gold serve as a potent chemical catalyst

Unit V

Molecular self-assembly

2. **Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):**

Modern, synthetic, method, manufacture, polymer, pharmaceuticals, commercial, supramolecular, utilize, automatically, configuration, enzyme, protein, component, biology, principle.

3. **Practice the following words:**

Pharmaceuticals [fa:mə'sju:tikəl], enzyme ['enzaim], protein ['prəuti:n], chemical ['kemikəl].

4. **Study the vocabulary list:**

Pharmaceuticals – фармацевтические препараты
polymers – полимеры
conformation – структура
enzyme – фермент
enzyme-substrate – фермент субстратный
supramolecula chemistry – супрамолекулярная химия
single molecules – отдельные молекулы

5. **Read and translate the text.**

Simple to complex: a molecular perspective

Modern synthetic chemistry has reached the point where it is possible to prepare small molecules to almost any structure. These methods are used today to manufacture a wide variety of useful chemicals such as pharmaceuticals or commercial polymers. This ability raises the question of extending this kind of control to the next-larger level, seeking methods to assemble these single molecules into supramolecular assemblies consisting of many molecules arranged in a well defined manner. These approaches utilize the concepts of molecular self-assembly and /or supramolecula chemistry to automatically arrange themselves into some useful conformation through a bottom-up approach. The concept of molecular recognition is especially important: molecules can be designed so that a specific configuration or arrangement is favored due to non-covalent intermolecular forces. The Watson–Crick basepairing rules are a direct result of this, as is the specificity of an enzyme being targeted to a single substrate, or the specific folding of the protein itself. Thus, two or more components can be designed to be complementary and mutually attractive so that they make a more complex and useful whole. Such bottom-up approaches should be capable of producing devices in parallel and be much cheaper than top-down methods, but could potentially be overwhelmed as the size and complexity of the desired assembly increases. Most useful structures require complex and thermodynamically unlikely arrangements of atoms. Nevertheless, there are many examples of self-assembly based on molecular recognition in biology, most notably Watson–Crick basepairing and enzyme-substrate interactions. The challenge for nanotechnology is whether these principles can be used to engineer new constructs in addition to natural ones.

6. Find in the text English word-combinations corresponding to the following Russian ones:

Производить широкое разнообразие фармацевтических препаратов**;** специфика ферментов и полимеров; специфика ферментов; сворачивание белка; отдельные молекулы; супрамолекулярная химия; структура молекулы; устройство атомов; самоорганизация молекул.

7. Translate the following into Russian:

To prepare small molecules to almost any structure; to assemble single molecules into supramolecular assemblies; to arrange molecules in a well defined manner; to arrange molecules into useful conformation; to utilize the concepts of molecular self-assembly; the concept of molecular recognition; non-covalent intermolecular forces; arrangements of atoms; the folding of the protein; enzyme-substrate interactions.

8. Answer the questions to the text:

1) What point has modern synthetic chemistry reached?
2) What are methods of synthetic chemistry used for?
3) What question does modern synthetic chemistry raise?
4) Why is the concept of molecular recognition important?
5) What are direct results of molecular recognition?
6) Why bottom-up approaches can be overwhelmed?

Unit VI

Molecular nanotechnology

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Machine, mechanosynthesis, technology, biometric, program, positional, hybrids, silicon, individual, publication, demonstrate, leader, laboratory, experiment.

2. Practice the following words:

Monoxide [mə'na:ksaid], hybrid ['haibrid], silicon ['silikən], oscillator ['a:sileitə].

3. Study the vocabulary list:

Molecular nanotechnology – молекулярная нанотехнология
monoxide – одноокись
oscillator – генератор
premise – предпосылка
voltage – напряжение

4. Read and translate the text.

Molecular nanotechnology: a long-term view

Molecular nanotechnology, sometimes called molecular manufacturing, describes engineered nanosystems (nanoscale machines) operating on the molecular scale. Molecular nanotechnology is especially associated with the molecular assembler, a machine that can produce a desired structure or device atom-by-atom using the principles of mechanosynthesis. Manufacturing in the context of productive nanosystems is not related to, and should be clearly distinguished from, the conventional technologies used to manufacture nanomaterials such as carbon nanotubes and nanoparticles. When the term "nanotechnology" was independently coined and popularized by Eric Drexler (who at the time was unaware of an earlier usage by Norio Taniguchi) it referred to a future manufacturing technology based on molecular machine systems. The premise was that molecular scale biological analogies of traditional machine components demonstrated molecular machines were possible: by the countless examples found in biology, it is known that sophisticated, stochastically optimised biological machines can be produced.

It is hoped that developments in nanotechnology will make possible their construction by some other means, perhaps using biomimetic principles. However, Drexler and other researchers have proposed that advanced nanotechnology, although perhaps initially implemented by biomimetic means, ultimately could be based on mechanical engineering principles, namely, a manufacturing technology based on the mechanical functionality of these components (such as gears, bearings, motors, and structural members) that would enable programmable, positional assembly to atomic specification. The physics and engineering performance of exemplar designs were analyzed in Drexler's book *Nanosystems*. In general it is very difficult to assemble devices on the atomic scale, as all one has to position atoms on other atoms of comparable size and stickiness. Another view, put forth by Carlo Montemagno, is that future nanosystems will be hybrids of silicon technology and biological molecular machines. Yet another view, put forward by the late Richard Smalley, is that mechanosynthesis is impossible due to the difficulties in mechanically manipulating individual molecules. This led to an exchange of letters in the ACS publication Chemical & Engineering News in 2003.Though biology clearly demonstrates that molecular machine systems are possible, non-biological molecular machines are today only in their infancy. Leaders in research on non-biological molecular machines are Dr. Alex Zettl and his colleagues at Lawrence Berkeley Laboratories and UC Berkeley. They have constructed at least three distinct molecular devices whose motion is controlled from the desktop with changing voltage: a nanotube nanomotor, a molecular actuator, and a nanoelectromechanical relaxation oscillator. An experiment indicating that positional molecular assembly is possible was performed by Ho and Lee at Cornell University in 1999. They used a scanning tunneling microscope to move an individual carbon monoxide molecule (CO) to an individual iron atom (Fe) sitting on a flat silver crystal, and chemically bound the CO to the Fe by applying a voltage.

5. Find in the text English words and word-combinations corresponding to the following Russian ones:

Углеродные нанотрубки; наночастицы; производить наноматериалы; действовать на молекулярном уровне; основываться на механических инженерных принципах; управлять движением молекул; молекулярная нанотехнология; разработки в нанотехнологии.

6. Discuss with your group mates whether the following statements are true or false:

1) Molecular nanotechnology and molecular manufacturing mean the same.

2) Molecular assembler is a machine, that produce desired struc ture or device atom-by-atom using the principles of mechanosynthesis.

3)Molecular manufacturing is related to technologies used to manufacture nanomaterials such as carbon nanotubes and nanoparticles.

4)It is not an easy matter to assemble devices on the atomic scale, as all one has to position atoms on other atoms of comparable size and stickiness.

5)The possibility of molecular machine systems is undoubted.

6)Non-biological molecular machines are in wide usage today.

7.Convert nouns into adjectives:

Convention	- **al**	conventional
biology		
commerce		
position		
function		
nation		

9. Use the noun suffixes to convert verbs into nouns:

Operate	- **Tion, sion**	operation
configurate		
associate		
popularize		
manipulate		
demonstrate		

10. Answer the following questions:

1) What does molecular nanotechnology describe?
2) What is molecular assembler?
3) Why is it difficult to assemble devices on the atomic scale?
4) What did leaders in research on non-biological molecular machines construct?
5) What did researchers from Cornell University use to indicate that positional molecular assembly is possible?

Unit VII

Nanomaterials

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Interface, fullerenes, transport, nanoionics, traditional, nanoelectronics

2. Practice the following words:

Colloid ['ka:loid], unique [ju:'ni:k], nanoionics [nænəuai'a:niks], nanoelectronics [nænəuilek'troniks], nanoromedicine [nænəu'medsən], flavour ['fleivə], solar ['səulə].

3. Study the vocabulary list:

colloid –коллоидный
solar – солнечный
to incorporate – включать
application – применение
unique - уникальный

4. Read and translate the text:

Nanomaterials

This includes subfields which develop or study materials having unique properties arising from their nanoscale dimensions.

- Interface and colloid science has given rise to many materials which may be useful in nanotechnology, such as carbon nanotubes and other fullerenes, and various nanoparticles and nanorods. Nanomaterials with fast ion transport are related also to nanoionics and nanoelectronics.
- Nanoscale materials can also be used for bulk applications; most present commercial applications of nanotechnology are of this flavor.
- Progress has been made in using these materials for medical applications.
- Nanoscale materials are sometimes used in solar cells which combats the cost of traditional Silicon solar cells
- Development of applications incorporating semiconductor nanoparticles to be used in the next generation of products, such as display technology, lighting, solar cells and biological imaging.
- **5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):**

1. уникальные свойства материалов	a. carbon nanotrubes
2. быть полезным в нанотехнологии	b. commercial application of nanotechnology
3. углеродные нанотрубки	c. fullerenes
4. фуллерены	d. new-generation materials
5. коммерческое применение нанотехнологии	e. to develop nanomedicine
6. развивать наномедицину	f. unique properties of materials
7. продукты нового поколения	g. to be useful in nanotechnology

6. Find antonyms (from the left column) to the words (from the right one):

1.to decrease	a. to assemble
2. reduction	b. to increase

3. to separate	c. extending
4. opaque	d. soluble
5. insoluble	e. transparent

7.Write a list of as many nanomaterials as you can think of. Compare your list with the lists of your group mates. Underline any nanomaterials that are not in your list.

8. Answer the following questions:

1) What materials has colloid science given rise to?
2) What materials are related to nanoionics and nanoelectronics?
3) What applications are nanoscale materials used for?

Unit VIII

The main approaches

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Conformation, utilize, nucleic, concept, supramolecular, automatically, silicon, microprocessor, magnetoresistance, nanoelectromechanical, microelectromechanical, nanolithography, analysis.

2. Practice the following words:

Nucleic [nju:'kli:k], acid ['æsid], nanolithography [nænəuli'θa:grəfi].

3. Study the vocabulary list:

to cause – причинять, вызывать
asid – кислота
to utilize - использовать
to descend –происходить
magnetoresistance – магнитосопротивление
nanolithography – нанолитография

4. Read and translate the texts.

Bottom-up approaches

These seek to arrange smaller components into more complex assemblies.

- DNA nanotechnology utilizes the specificity of Watson–Crick basepairing to construct well-defined structures out of DNA and other nucleic acids.
- Approaches from the field of "classical" chemical synthesis also aim at designing molecules with well-defined shape (e.g. bis-peptides).
- More generally, molecular self-assembly seeks to use concepts of supramolecular chemistry, and molecular recognition in particular, to cause single-molecule components to automatically arrange themselves into some useful conformation.

Top-down approaches

These seek to create smaller devices by using larger ones to direct their assembly.

- Many technologies that descended from conventional solid-state silicon methods for fabricating microprocessors are now capable of creating features smaller than 100 nm, falling under the definition of nanotechnology. Giant magnetoresistance-based hard drives already on the market fit this description, as do atomic layer deposition (ALD) techniques. Peter Grünberg and Albert Fert received the Nobel Prize in Physics for their discovery of Giant magnetoresistance and contributions to the field of spintronics in 2007.
- Solid-state techniques can also be used to create devices known as nanoelectromechanical systems or NEMS, which are related to microelectromechanical systems or MEMS.
- Atomic force microscope tips can be used as a nanoscale "write head" to deposit a chemical upon a surface in a desired pattern in a process called dip pen nanolithography. This fits into the larger subfield of nanolithography.

- Focused ion beams can directly remove material, or even deposit material when suitable pre-cursor gasses are applied at the same time. For example, this technique is used routinely to create sub-100 nm sections of material for analysis in Transmission electron microscopy.

5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):

1. организовывать молекулы в полезные структуры	a. to fall under the definition of nanotechnology
2. получать Нобелевскую премию по физике	b. to be related to microelectromechanical systems
3. относиться к электромеханическим системам	c. to arrange molecules into useful conformation
4. организовывать меньшие компоненты в более сложные	d. to construct structures out of DNA and nucleic acids
5. создавать структуры из ДНК и нуклеиновых кислот	e. to receive the Nobel Prize in Physics
6. создавать меньшие материалы посредством использования-больших	f. to arrange smaller components into more complex
7. попадать под определение нанотехнологии	g. to create smaller devices by using larger ones

6. Insert the prepositions into the following sentences:

1) Bottom-up approaches seek to arrange smaller components … more complex assemblies.

2) DNA nanotechnology utilizes the specificity … Watson–Crick basepairing to construct well-defined structures … … DNA and other nucleic acids.

3) Approaches … the field of "classical" chemical synthesis also aim … designing molecules … well-defined shape

4) Molecular self-assembly seeks to use concepts … molecular recognition to cause single-molecule components to automatically arrange themselves … some useful conformation.

5) Top-down approaches seek to create smaller devices … using larger ones to direct their assembly.

6) Peter Grünberg and Albert Fert received the Nobel Prize … Physics … their discovery … Giant magnetoresistance and contributions … the field … spintronics … 2007.

7) Atomic force microscope tips can be used … a nanoscale "write head" to deposit a chemical … a surface … a desired pattern.

7. Answer the following questions:

1) What does Bottom-up approach seek?

2) What does molecular self-assembly use concepts molecular recognition for?

3) What is top-down approach?

4) What did Peter Grünberg and Albert Fert receive the Nobel Prize in Physics for?

5) What is nanolithography?

Unit IX

Other approaches

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Rataxane, motor, design, biomineralization, bionanotechnology, biomolecule, manipulate, theoretical,nanorobotics, progress, methodology, progressive, patent, popularity, picotechnology, femtotechnology.

2. Practice the following words:

Component [kəm'pəunənt], functionality [fΛnkʃə'næliti], patent ['peitent], method ['meθəd], nature ['neitʃə], inquiry [ink'waiəri], societal [sə'saiətl], synthetic [sin'θetik].

3. Study the vocabulary list:

functionality – функциональность
bionics – бионика
inquiry – исследование
speculative – теоретический
societal – социальный
drawback – недостаток
patent – патент
artificial – искусственный
exposure – обнародование

4. Read and translate the texts.

Functional approaches

These seek to develop components of a desired functionality without regard to how they might be assembled.

- Molecular electronics seeks to develop molecules with useful electronic properties. These could then be used as single-molecule components in a nanoelectronic device. For an example see rotaxane.
- Synthetic chemical methods can also be used to create synthetic molecular motors, such as in a so-called nanocar.

Biomimetic approaches

- Bionics or biomimicry seeks to apply biological methods and systems found in nature, to the study and design of engineering systems and modern technology. Biomineralization is one example of the systems studied.
- Bionanotechnology the use of biomolecules for applications in nanotechnology.

Speculative

These subfields seek to anticipate what inventions nanotechnology might yield, or attempt to propose an agenda along which inquiry might progress. These often take a big-picture view of nanotechnology, with more emphasis on its societal implications than the details of how such inventions could actually be created.

- Molecular nanotechnology is a proposed approach which involves manipulating single molecules in finely controlled, deterministic ways. This is more theoretical than the other subfields and is beyond current capabilities.
- Nanorobotics centers on self-sufficient machines of some functionality operating at the nanoscale. There are hopes for applying nanorobots in medicine, but it may not be easy to do such a thing because of several drawbacks of such devices. Nevertheless, progress on innovative materials and methodologies has been demonstrated with some patents granted about new nanomanufacturing devices for future commercial applications, which also progressively helps in the development towards nanorobots with the use of embedded nanobioelectronics concepts.
- Programmable matter based on artificial atoms seeks to design materials whose properties can be easily, reversibly and externally controlled.
- Due to the popularity and media exposure of the term nanotechnology, the words picotechnology and femtotechnology have been coined in analogy to it, although these are only used rarely and informally.

5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):

1. теоретический подход	a. innovative materials
2. молекулы с полезными электронными свойствами	b. to seek to apply biological methods and systems
3. стремиться применять биологические методы и системы	c. applying nanorobots in medicine
4. изобретения нанотехнологии	d. molecules with useful electronic properties
5. применение нанороботов в медицине	e. artificial atoms
6. инновационные материалы	f. the inventions of nanotechnology

7. искусственные атомы g. speculative approach

6.Arrange synonyms in pairs:

To use	to produce
to manufacture	to utilize
conformation	Research
Diverse	Structure
Investigation	Single
Individual	Theoretical
to enhance	to demonstrate
to exhibit	to increase
Speculative	various

7. Answer the following questions:

1)What is functional approach?
2)What does molecular electronics seek to develop?
3)What is bionics?
4)What does speculative approach seek to?
5)What does speculative approach make emphasis on?

Unit X

Tools and techniques

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Version, idea, acoustic, methodology, nanomanipulations, process, nanolithography, lithography, fabrication, ultraviolet.

2. Practice the following words:

Tunneling ['tΛnliŋ], acoustic [ə'ku:stik], technique [tek'ni:k], ultraviolet [Λltrə'vaiəlit], vapor ['veipə].

3. Study the vocabulary list:

probe – зонд
to launch – запускать, начинать
scanning probe microscopy – сканирующая зондовая микроскопия
acoustic – акустический
coworker – сотрудник
to implement – вовлекать, внедрять
velocity – скорость
X-ray – рентген
ultraviolet – ультрафиолетовый
vapor – пар, газ
epitaxy – эпитаксия
confocal – софокусный

4. Read and translate the text.

Tools and techniques

There are several important modern developments. The atomic force microscope (AFM) and the Scanning Tunneling Microscope (STM) are two early versions of scanning probes that launched nanotechnology. There are other types of scanning probe microscopy, all flowing from the ideas of the scanning confocal microscope developed by Marvin Minsky in 1961 and the scanning acoustic microscope (SAM) developed by Calvin Quate and coworkers in the 1970s, that made it possible to see structures at the nanoscale. The tip of a scanning probe can also be used to manipulate nanostructures (a process called positional assembly). Feature-oriented scanning-positioning methodology suggested by Rostislav Lapshin appears to be a promising way to implement these nanomanipulations in automatic mode. However, this is still a slow process because of low scanning velocity of the microscope. Various techniques of nanolithography such as optical lithography, X-ray lithography dip pen nanolithography, electron beam lithography or nanoimprint lithography were also developed. Lithography is a top-down fabrication technique where a bulk material is reduced in size to nanoscale pattern.

Another group of nanotechnological techniques include those used for fabrication of nanowires, those used in semiconductor fabrication such as deep ultraviolet lithography, electron beam lithography, focused ion beam machining, nanoimprint lithography, atomic layer deposition, and molecular vapor deposition, and further including molecular self-assembly techniques such as those employing di-block copolymers. However, all of these techniques preceded the nanotech era, and are extensions in the development of scientific advancements rather than techniques which were devised with the sole purpose of creating nanotechnology and which were results of nanotechnology research.

The top-down approach anticipates nanodevices that must be built piece by piece in stages, much as manufactured items are made. Scanning probe microscopy is an important technique both for characterization and synthesis of nanomaterials. Atomic force microscopes and scanning tunneling microscopes can be used to look at surfaces and to move atoms around. By designing different tips for these microscopes, they can be used for carving out structures on surfaces and to help guide self-assembling structures. By using, for example, feature-oriented scanning-positioning approach, atoms can be moved around on a surface with scanning probe microscopy techniques. At present, it is expensive and time-consuming for mass production but very suitable for laboratory experimentation.

In contrast, bottom-up techniques build or grow larger structures atom by atom or molecule by molecule. These techniques include chemical synthesis, self-assembly and positional assembly. Dual polarisation interferometry is one tool suitible for characterization of self assembled thin films. Another variation of the bottom-up approach is molecular beam epitaxy or MBE. Researchers at Bell Telephone Laboratories like John R. Arthur. Alfred Y. Cho, and Art C. Gossard developed and implemented MBE as a research tool in the late 1960s and 1970s. Samples made by MBE were key to the discovery of the fractional quantum Hall effect for which the 1998 Nobel Prize in Physics was awarded. MBE allows scientists to lay down atomically precise layers of atoms and, in the process, build up complex structures. Important for research on semiconductors, MBE is also widely used to make samples and devices for the newly emerging field of spintronics.

However, new therapeutic products, based on responsive nanomaterials, such as the ultradeformable, stress-sensitive Transfersome vesicles, are under development and already approved for human use in some countries.

5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):

1.Сканирующие зонды	a) scanning acoustic microscope
2. запускать нанотехнологию	b) various techniques of nanolithography
3. сканирующий акустический микроскоп	c) scanning probes
4. управлять наноструктурами	d) to launch nanotechnology
5. из-за медленной сканирующей скорости микроскопа	e)an important technique for characterization and synthesis of nanomaterials.
6. уменьшать материалы в размере до образца наноуровня	f) because of low scanning velocity of the microscope
7. важный технологический прием для описания и синтеза наноматериалов	g) self-assembling structures
8. различные технологические приемы нанолитографии	h) to reduce materials in size to nanoscale pattern
9. изготовление нанопроводов	i) to manipulate nanostructures
11. перемещать атом по поверхности	j) fabrication of nanowires
12. наноимпринтная литография	k) ultraviolet lithography
13. самоорганизация структур	l) to move atoms on the surface
14. УФ литография	
15. электронно-пучковая литография	m) nanoiprint lithography

16. диблоксополимер	n) di-block copolymer
17. интерферометрия двойной поляризации	o) electron beam lithography
18. эффект Холла	p) Hall effect
19. молекулярно лучевая эпитоксия	q) dual polarization interferometry
	r) molecular beam epitaxy

6.Arrange synonyms in pairs:

To include	to alter
to operate	to explore
to investigate	to manipulate
Matter	Outcome
Production	Manufacturing
Plausible	Question
Result	Possible
to change	to incorporate

7. Answer the questions:

1)What are two early versions of scanning probes that launched nanotechnology?
2)What techniques of nanolithography were developed?
3)What are atomic force microscopes and scanning tunneling microscopes used for?
4)What was molecular beam epitaxy (MBE) implemented for?
5)What opportunities does MBE give scientists?

Unit XI

Applications

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Project, limit, titanium, cosmetics, allotropes, furniture, cerium, catalyst, monograph, detoxify.

2. Practice the following words:

Titanium [tai'teniəm], dioxide [dai'oksaid], membrane ['membrein].

3. Study the vocabulary list:

to estimate – оценивать
titanium – титан
dioxide – диоксид
sunscreen – солнцезащитный крем
gecko – геккон
disinfectants – дезинфицирующие средства
coating – покрытие
paints – краски
varnishes – лак, лакировка
cerium – церий
to fund – финансировать

4. Read and translate the text.

Nanotechnology application

As of August 21, 2008, the Project on Emerging Nanotechnologies estimates that over 800 manufacturer-identified nanotech products are publicly available, with new ones hitting the market at a pace of 3–4 per week. The project lists all of the products in a publicly accessible on-line.

Most applications are limited to the use of "first generation" passive nanomaterials which includes titanium dioxide in sunscreen, cosmetics and some food products; Carbon allotropes used to produce gecko tape; silver in food packaging, clothing, disinfectants and household appliances; zinc oxide in sunscreens and cosmetics, surface coatings, paints and outdoor furniture varnishes; and cerium oxide as a fuel catalyst.

The National Science Foundation (a major distributor for nanotechnology research in the United States) funded researcher David Berube to study the field of nanotechnology. His findings are published in the monograph Nano-Hype: The Truth Behind the Nanotechnology Buzz. This study concludes that much of what is sold as “nanotechnology” is in fact a recasting of straightforward materials science, which is leading to a “nanotech industry built solely on selling nanotubes, nanowires, and the like” which will “end up with a few suppliers selling low margin products in huge volumes." Further applications which require actual manipulation or arrangement of nanoscale components await further research. Though technologies branded with the term 'nano' are sometimes little related to and fall far short of the most ambitious and transformative technological goals of the sort in molecular manufacturing proposals, the term still connotes such ideas. According to Berube, there may be a danger that a "nano bubble" will form, or is forming already, from the use of the term by scientists and entrepreneurs to garner funding, regardless of interest in the transformative possibilities of more ambitious and far-sighted work.

Nano-membranes have been produced that are portable and easily-cleaned systems that purify, detoxify and desalinate water meaning that third-world countries could get clean water, solving many water related health issues.

5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):

1. доступные нанопродукты	a) Nanotechnology application
2. применение нанотехнологий	b) available nanoproducts
3. изучать сферу нанотехнологий	c) molecular manufacturing
4. переносимая и легкоочищаемая система	d) to study the field of nanotechnology
5. Очищать воду для стран третьего мира	e) to be related to the most ambitious technological goals
6. молекулярное производство	f) portable and easily-cleaned systems

7. относиться к самым амбициозным технологическим целям	g) to purify water for third-world countries
8. создавать наножевачку	h) to form "nano bubble"

6. Complete the following sentences:

a. The"first generation" of passive nanomaterials includes … .

b. A major distributor for nanotechnology research in the United States is … .

c. David Berube's study concludes that much of what is sold as "nanotechnology" is in fact … .

d. Nano-membranes are … systems for … .

7. Use the noun suffixes to convert verbs into nouns:

Distribute	**-tion, sion**	destribution
Characterize		
Anticipate		
Fabricate		
Advance	**-ment**	advancement
Arrange		

6. Answer the questions:

1) What did the Project on Emerging Nanotechnologies estimate in August 21, 2008?
2) What do "first generation" of passive nanomaterials include?
3) Why did a major distributor for nanotechnology fund David Berube?
4) What did David Berube published in his monograph? What does he concern about?
5) What are the purposes of nano-membranes?

Unit XII

Implications

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Commercialization, adequate, nanotoxicology, center, regulate, innovation, destabilize, cameras, industrial, expert, director, risk, result.

2. Practice the following words:

Potential [pə'tenʃəl], society [sə'saiəti], weapon ['wepən], government ['gΛvnmənt], environment [in'vaiərəmənt], scientific [saiən'tifik].

3. Study the vocabulary list:

implication – значение
claim – заявление, протест
potential – потенциальный
concern – беспокойство, важное дело
effect – действие
appropriate – подходящий, соответствующий
to mitigate – смягчать, ослаблять
weapon – оружие
to advocate – защищать
to stifle – душить
to benefit – приносить пользу
to testify – свидетельствовать

4. Read and translate the text.

Implication of nanotechnology

Because of the far-ranging claims that have been made about potential applications of nanotechnology, a number of serious concerns have been raised about what effects these will have on our society if realized, and what action if any is appropriate to mitigate these risks.

There are possible dangers that arise with the development of nanotechnology. The Center for Responsible Nanotechnology suggests that new developments could result, among other things, in untraceable weapons of mass destruction, networked cameras for use by the government, and weapons developments fast enough to destabilize arms races ("Nanotechnology Basics").

One area of concern is the effect that industrial-scale manufacturing and use of nanomaterials would have on human health and the environment, as suggested by nanotoxicology research. Groups such as the Center for Responsible Nanotechnology have advocated that nanotechnology should be specially regulated by governments for these reasons. Others counter that overregulation would stifle scientific research and the development of innovations which could greatly benefit mankind.

Other experts, including director of the Woodrow Wilson Center's Project on Emerging Nanotechnologies David Rejeski, have testified that successful commercialization depends on adequate oversight, risk research strategy, and public engagement. Berkeley, California is currently the only city in the United States to regulate nanotechnology; Cambridge, Massachusetts in 2008 considered enacting a similar law, but ultimately rejected this.

5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):

1. делать заявление	a) weapons of mass destruction
2. потенциал применений нанотехнологий	b) to mitigate risk of arising concerns
3. иметь воздействие на общество	c) to make claims
4. уменьшать риск возрастающих беспокойств	d) the effect of the usage of nanomaterials on human health
5. оружие массового уничтожения	e) to have effect on society
6. результат использования наноматериалов на человеческое здоровье	f) the effect of industrial manufacturing of nanomaterials on the environment
7. воздействие промышленного производства наноматериалов на окружающую среду	g) potential applications of nanotechnology
8. приносить пользу человечеству	h) to benefit mankind
9. значение нанотехнологии	i) implication of nanotechnology

6. Discuss with your group mates whether the following statements are true or false:

1) There are no serious concerns about the potential applications of nanotechnology in modern society.

2) New developments of nanotechnology can result in untraceable weapons of mass destruction.

3) Overregulation of nanotechnology by governments would benefit mankind greatly.

4) The most important concern is the effect that industrial-scale manufacturing of nanomaterials has on human health.

7. Answer the questions:

1) Which concerns has potential applications of nanotechnology arisen?

2) What are the dangers of the development of nanotechnology?

3) What does successful commercialization of nanotechnology depend on?

Unit XIII

Health and environmental concerns

1. Try to guess the meaning of the following words. Discuss with your group mates whether they are nouns (n), verbs (v) or adjectives (adj):

Bacteriostatic, organic, stress, public, nano-titanium, chromosome, neurological, form, poster, revolution, institute, sort.

2. Practice the following words:

Consequence ['konsikwəns], odor ['oudə], oxidative [a:ksi'deitiv], chromosome ['krəuməsəum], disease [di'zi;z], asbestos [æs'bestəs], lung [lΛŋ].

3. Study the vocabulary list:

unintended – непреднамеренный
consequences – последствия
bacteriostatic – бактериостатический
beneficial – полезный

to induce – побуждать, вызывать
oxidative – окислительный
chromosome – хромосома
cancer – рак
disease – болезнь
aging – старение
neurological – неврологический
asbestos – асбест
mesothelioma – мезотелиома
lungs – легкие
to inhale – вдыхать

4. Read and translate the text.

Health implications of nanotechnology and Environmental implications of nanotechnology

Some of the recently developed nanoparticle products may have unintended consequences. Researchers have discovered that silver nanoparticles used in socks only to reduce foot odor are being released in the wash with possible negative consequences. Silver nanoparticles, which are bacteriostatic, may then destroy beneficial bacteria which are important for breaking down organic matter in waste treatment plants or farms.

A study at the University of Rochester found that when rats breathed in nanoparticles, the particles settled in the brain and lungs, which led to significant increases in biomarkers for inflammation and stress response. A study in China indicated that nanoparticles induce skin aging through oxidative stress in hairless mice.

A two-year study at UCLA's School of Public Health found lab mice consuming nano-titanium dioxide showed DNA and chromosome damage to a degree "linked to all the big killers of man, namely cancer, heart disease, neurological disease and aging".

A major study published more recently in Nature Nanotechnology suggests some forms of carbon nanotubes – a poster child for the “nanotechnology revolution” – could be as harmful as asbestos if inhaled in sufficient quantities. Anthony Seaton of the Institute of Occupational

Medicine in Edinburgh, Scotland, who contributed to the article on carbon nanotubes said "We know that some of them probably have the potential to cause mesothelioma. So those sorts of materials need to be handled very carefully." In the absence of specific nano-regulation forthcoming from governments, Paull and Lyons (2008) have called for an exclusion of engineered nanoparticles from organic food. A newspaper article reports that workers in a paint factory developed serious lung disease and nanoparticles were found in their lungs.

5. Compare two columns of words and find Russian equivalents (from the right column) to the following English words (from the left one):

1. иметь непреднамеренные последствия	a) to develop serious lung disease
2. использовать бактериостатические серебряные наночастицы	b) to induce skin aging
3. уничтожать полезные бактерии	c) to have unintended consequences
4. вызывать старение кожи	d) to use bacteriostatic silver nanoparticles
5. вдыхать достаточное количество асбеста	e) to find nanoparticles in lungs
6. развивать заболевания легких	f) to inhale in sufficient quantities of asbestos
7. находить наночастицы в легких	g) to destroy beneficial bacteria

6.Discuss with your groupmates whether the following statements are true or false:

1) Recently developed nanoparticle products always have positive consequences.
2) Breathing in nanoparticles leads to significant increases in biomarkers for inflammation and stress response among rats.
3) Lab mice consuming nano-titanium dioxide leads to cancer.
4) Some forms of carbon nanotubes may cause mesothelioma.

5) Workers in a paint factory usually suffer from lung disease and nanoparticles are found in their lungs.

7. Answer the questions:

1) What consequences may recently developed nanoparticle products have?
2) What bacteria may silver nanoparticles destroy?
3) Which diseases may lab mice consuming nano-titanium dioxide cause?
4) Why carbon nanotubes need to be handled very carefully?

Texts for supplementary reading

Nanolayers

New light-emitting materials are made possible by nano-structuring semiconducting materials. The vertical cavity surface emitting laser (VCSEL), in whose development Sandia National Laboratories played a major role, is a good example of a nanomaterial that uses layered quantum well structures to produce highly efficient, low power-consumption light sources. A key to achieving high efficiency and optical control is the quantum confinement that results from designing and building materials with chemically distinct layers that are on the order of 10 ran thick.

An example of a VCSEL with its nanolayered material structure is shown in Figure I VCSELs have now been developed to emit light, in the infrared through visible and into the ultra, violet (Li V) wavelength range.

Today, semiconductor quantum well light-emitting structures are used in optical communications, image scanning, laser pointing and surveying, printing, and computing. Tomorrow, the potential exists for these materials to replace everyday use of fluorescent and incandescent lighting with significant energy and cost savings. This new technology, often called solid-state lighting, is already employed in many of today's highwaytraffic signals. (These signals are recognizable by their unique pattern of illuminated dots of light.) Solid-state traffic signals are 10 times more efficient than the filtered red light technology that they replace! Even though current solid-state semiconductor lights are more than two orders of magnitude more expensive than incandescent light bulbs, municipalities are able to recoup this extra cost in as little as one year, due to their dramatically reduced consumption of electricity. Thereafter, solid-state lighting traffic signals save $1000 in electricity per intersection per year. Because solid-state light sources are longer lasting than conventional sources, their considerably reduced maintenance only adds to the cost savings. Applying these efficiency gains to general white-light illumination could reduce the U.S. electric bill by about S25 billion per year while reducing, by 28 million metric tons per year, the carbon that is emitted from power plants into the atmosphere. Full realization of the energy and environmental benefits of general-application solid-state lighting will require advances in our ability to design, control, and cost-effectively manufacture these nanostructured light-emitting materials.

Researchers at Sandia and the University of New Mexico (UNM) Medical School are exploring the use of VCSELs to discriminate and sort living human cells. A device called a *BioCavitxLaser* incorporates individual living cells into the VCSEL structure. In the BioCavityLaser, the VCSEL is integrated with a microscale fluid channel so that individual cells m the fluid medium can be positioned within the semiconductor laser cavity, while in the laser cavity, the cells impart their optical characteristics on the output of the laser, allowing subtle differences in cell character to be distinguished. In this way. a flowing stream can be used to pass many cells, one after another, through the laser cavity where their signatures are collected in about one one-thousandth of a second's time. The joint Sandia/UNM research team has shown that this approach can be used to distinguish between healthy human brain tissue and cancerous brain tissues by examining only a few hundred cells. This research opens the potential for one day guiding a surgeon's scalpel to remove cancerous tissue while preserving surrounding healthy organs. Other potential applications for this technology include detection of biological pathogens in the environment or food supplies,

Nanolayered metallic materials also exhibit extraordinary magnetic and mechanical properties. In fact, nanoscale layered magnetic materials are responsible for many of today's dramatic improvements in magnetic, data storage, while research in nanolayered "exchange spring" magnets holds the promise for tomorrow's more efficient, energy-saving electric motors. Since magnetism is a collective phenomenon, control over nanoscale structure offers new opportunities to modify and manipulate the magnetic behavior in a fundamental way. The ability to build controlled nanolayer magnetic materials has paved the way for several new discoveries. There are known variously as giant magneton:-sistance, tunneling magnetoresistance. exchange bias, and interlayer exchange coupling. They are providing a rich new tool set to create a variety of sensors used for diverse applications, ranging from read heads of magnetic storage devices to motion sensors used to monitor the rotational position of robotic machinery.

Nanolayered metallic materials also show extraordinary mechanical properties. For example, nanostructured copper/ stainless steel multilayers with layer thicknesses on the order of 5 run are twice as hard as one would predict from a purely continuum rule of mixtures model.

Nanocrystals

In nanocrystals, size becomes a variable that can be used to "tune" a wide range of properties. For example, quantum confinement of electrons can be used to tune electrical, magnetic, and optical properties of semiconductor quantum dots or "Q-dots." Q-dots hold significant potential as fluorescent tags that enable the tracking of biological processes and sub-cellular metabolic processes. In this application, (he Q-dot is joined with a biological receptor that can recognize and attach to a specific component of a living system. The fluorescent signal of the Q-dot may then be used lo follow biological processes in real time. Q-dots offer advantages over conventional fluorescent probes because they can be tuned to emit over a wide range of colors, yet require only a single excitation source to drive emission. This feature can allow many individual biological processes to be tracked simultaneously. Semiconductor Q-dots are also much more resistant to photo-bleaching, which limits the brightness of the fluorescent signal that can be obtained using conventional probes.

Sandia scientists and engineers have begun exploring the potential for using cadmium sulfide Q-dots as next-generation phosphors for general illumination applications. By encapsulating Q-dots in a polymer matrix and applying that coating to a semiconductor ultraviolet light emitter, they have been able to demonstrate up to 70 pet quantum efficiency for ultraviolet to visible light conversion. While this quantum efficiency is only about as good as conventional micron-sized phosphor materials, the nanocrystals produce nearly 25 pet less light scattering. This greatly reduces the amount of light that would normally scatter back into the emitter source, increasing the amount available for illumination.

Researchers at Sandia have also demonstrated that silicon Q-dots can generate light where bulk silicon, as an indirect bandgap semiconductor, cannot. We have successfully grown size-selected Si nanoclusters in the size range 1.8 to 10 nm as shown in Figure 2, and have observed room-temperature photoluminescence at wavelengths across the visible range. 700 to 350 nm (1.8 to 3.5 e V). This discovery opens the door to future silicon-based microelectronics that can directly integrate optical functions for communications or chemical/biological sensing.

Sandia researchers have also demonstrated total destruction (called total mineralization) of several toxic organic chemicals through the use of nanosize MoS_2 and sunlight. One of the most important of these chemicals is penta-chlorophenol (or PCP), a widely used wood preservative ubiquitous in the industrialized world. We demonstrated complete mineralization of PCP using only light with wave length between 700 and 400 nm at a rate that significantly-exceeded that of existing approaches that also require high-energy UV excitation. This application combines the tunable optical properties of Q-dots with their enhanced chemical activity.

Three-dimensional Nanomaterials

Patterning techniques, including electron beam lithography and nanoimprint lithography, have become increasingly-effective in their ability to produce two-dimensional structures with nanometer-scale resolution. However, these "top-down" patterning approaches are not well suited to synthesis of fully three-dimensional (3-D) nanomaterials. Molecular self-assembly, extensively used in biological systems, is extremely well suited for the production of extended 3-D structures with nanoscale periodicity, including porous and solid composite materials. The self-assembly processes make use of fundamental interactions between the individual building blocks (atoms, molecules, and nanocrystals) to self-organize ordered structures with periodicities many times larger than the fundamental building block units themselves. Inorganic, organic, and hybrid nanomaterials can be formed in this fashion. Figure 3 shows a 3-D ordered porous silica film that was polymerized from a surfactant, oil. and water mixture. Materials made in this way are unique in thai each pore is identical to the next, a property not generally found in conventional porous structures.

At Sandia, we are employing self-assembled nanoporous silica films to selectively capture and preconcentrate target chemicals for detection and identification. Our /xCheml.ab device provides all the functions of laboratory chemical analysis—sample pretreatment, chromatographic separations, and detection—integrated into a hand-portable, battery operated device capable of parts-per-billion detection of target chemical analytes in just 1 to 2 minutes. The ability to miniaturize chemical analysis has immediate application for homeland security purposes, and has the potential to provide many new applications for environmental sensing and point-of-care health monitoring.

Sandia researchers are also exploring self-assembly strategies than can be used to create nanoscale organic/inorganic hybrid materials. The goal is to develop systems in which organic and inorganic constituents can be mixed in a way that enables direct and simultaneous formation of a fully formed hybrid nanocomposite structure. Nanoscale hybrids offer the possibility to capture the best of both worlds; inorganic materials are dimensionally stable and robust, while organic materials can reconfigure to adapt and heal. A recent example is the self-assembly of mesoscopically ordered chromatic polydi-acetylene/silica nanocomposites. Polydiacetylenc (PDA) is a highly conjugated organic polymer that exhibits electronic and optical properties suitable for applications rarfging from light-emitting diodes to biomolecular sensors. Chemical and biological sensing in these polymers is achieved when target analyte binding causes subtle shifts in the organic back-bond structure, causing optical (color) changes in the polymer. Using specially developed diacetylene molecules with structure-directing functional groups, this research team was able to synthesize PDA/silica nanocomposites that are optical-ly transparent and mechanically more robust than their fully organic counterparts. Additionally, the PDA nanocomposite shows a reversible chemical sensing behavior not seen in most organic materials.

Three-dimensional nanomaterials hold great potential for applications ranging from new drug delivery systems to lightweight structural materials, to ultra-low dielectric constant coatings electronic applications.

Manufacturing

Successful nanoscale manufacturing requires the ability to control materials synthesis at the nanometer scale with sufficiently high reliability and yield to be cost effective. This challenge goes far beyond what is needed for laboratory scale synthesis and proof-of-principle research scale studies. If we do not meet this challenge, little hope can be held for many of the promising applications for nanotechnology.

The current success for nanolayered materials is no accident. Research and development on manufacturable approaches for nanolayered materials has enjoyed a long period of investment and is now quite highly evolved. For example, the quantum well lasers and solid-state light sources are produced through molecular beam epitaxy or metal-organic chemical-vapor deposition. Significant research and development on these techniques has been ongoing since the early 1980s. This investment has yielded very-well-defined models and understanding that allow routine manufacturing control at the level of individual atomic layers.

By comparison with nanolayered materials, our ability to control the growth of nanocrystals is at a relative state of infancy. Techniques using inverse micellar cages and metal-organic precipitation allow the laboratory scientist to synthesize a wide range of metal, semiconductor, and oxide nanocrystals. However, these techniques tend to work best as batch operations that can produce only small quantities of material. The control of nanocrystal size is very sensitive to reaction conditions that can result in a distribution of particle size and in batch-to-batch variations. Relatively recently, groups have begun experimenting with continuous micTofluidic reactor approaches to grow nanocrystals; however, it is too early to determine whether this approach can olfer better control and yield. Clearly, new tools that can be used to examine real-time formation of nanocrystals. coupled with modeling and simulation, will be required to develop the level of understanding and control needed to commercially manufacture nanocrystals. While materials like carbon black, which tire truly nanoscale, can be produced in high quantity, the production processes do not providethe size control necessary to take advantage of the unique chemical, optical, electronic, and magnetic properties offered by nanocrystals.

Most experts would agree that self-assembly promises to be an important tool for nanoscale. manufacturing; however. it too is in an early stage of development. A few systems, such as nanoporous silicates, under development since the early 1980s, have found their way into commercial applications as specialized catalysts. More recently, Sandia scientists and engineers have learned how to control the sell-assembly in the silica system well enough to reproducibh fabricate and pattern thin films with controlled, nanoporous structures. A key to achieving manufacturing control over self-assembly is the development of predictive models for self-assembly. While researchers are making considerable progress in modeling self-assembly for liquid-crystal templated systems, such as the porous silicates, a great deal of work is yet to be done to develop reliable models that can be used as engineering tools to design a wide range of self-assembled materials with predictable structure and properties.

A REVOLUTION IN PRODUCTION

We make nearly everything by tearing things apart. To make paper, trees are planted, chopped down and sent through our mills. This is often called a top-down method of production. But what if could work from the bottom up? What if paper was constructed atom by atom, the smallest building blocks of life and matter? It is thought that nanotechnology is the way to do this. Nanotechnology is the science of creating objects on a level smaller than 100 nanometres, a scale 50, 000 times smaller than a human hair. The aim of nanotechnology is the bottom-up production of virtually any material or object by assembling it one atom at a time.

Nanotechnology moved from idea to reality when tools such as the Atomic Force Microscope (AFM) and the Scanning Microscope (STM) were developed by IBM in Zurich. These microscopes do more than just let people see small things, they also allow atoms to be manipulated in a vacuum, liquid or gas. Individual atoms and molecules are probed by the AFM to create three-dimensional images at the nanoscale level as the microscope is moved across the surface of an object. STMs can etch surfaces and move individual particles. Even more advanced tools for nanoscale growth and nanoparticle assembly are under development.

There are two ways to produce nanostructures: they can be grown or assembled atom by atom. At present most nanotechnology applications begin with the growth of basic nanostructures rather than the assembly of materials and objects one atom at a time. By bonding a molecule with a particle, or single atom, scientists are able to create objects such as fullerenes: molecules of carbon atoms that when put together form tubular fibres, called nanotubes. These nanostructures include nanotubes, nnanohexagons and nanowires. Such nanostructures are used to create high-strength, low-weight materials – when these fibres are threaded together and crystallized they can act like metal, but are 100 timesstronger and four times lighter than steel. Nanostructures can also form super small electronic circuits – it is hoped that these structures will be used in computing and reduce the size of a computer to the size of a full stop. Other nanostructures are circular and include nanoshells, nanospheres and nanocircles. Circular nanostructures are used for energy wave reflection and can be found today in products like sun cream and self-cleaning glass. So far, most of these nanostructures have been relatively expensive to manufacture. However, production costs are dropping with the invention of more efficient manufacturing methods and nanomaterials are being used in a wider and wider range of products.

The field of nanotechnology has two major problems. The first is learning how to successfully manipulate material at the molecular and atomic level, using both chemical and mechanical tools. This is being developed by researchers and there are successes in the lab and practical applications. The second is to develop self-replicating nanomachines or nanobots. Nanobots are miniature robots that work on the scale of atoms and molecules. One of the most anticipated uses of nanotechnology is the creation of medical nanobots, made up of a few molecules, destroy cancer cells or construct nerve tissue atom by atom in order to end paralysis. Although they are made and function on the scale of atoms and molecules, nanobots will be able to work together to produce macroscale results. Precursor devices to nanobots have already been created, some can even walk. However, true nanobots have yet been created.

To produce objects from the bottom up at the level of atoms will need armies of advanced nanobots. There are classified into two types: assembly nanobots and a special class of assembly nanobots: self-replicators. Advanced nanobots will be able to sense and adapt to the environment, perform complex calculations, move, communicate, and work together; conduct molecular assembly; and, to some extent, repair or even reproduce themselves. Yet creating these nanobots is a slow and precise process due to the microscopic size of these tiny machines. Therefore the key to this technology becoming a reality is to make the nanobots replicate itself. It is the discovery of how to create this process, as well as the maens to control it, which is key to fulfilling the potential of nanotechnology.

Some environmentalists are concerned that nanobots may go wrong, leading to unlimited selfreplication. If this takes place, nanobots may destroy our ecosystem. While mankind must be careful to ensure that this does not occur, there is also the possibility that nanobots could form the ultimate environmentally-friendly recycling system. Nanobots may one day convert our mountains of trash and hazardous waste into useful products and beneficial materials.

Библиографический список

1. Свободная интернет-энциклопедия [www. wikipedia.ru].
2. A.D. Roming. Jr. Nanotechnology: Scientific Challenges and Societal Benefits and Risks.- 2004. – V.35A.
3. The Encyclopedia Britannica. – New York, 1979. – V. 1-24.